National Aeronautics and Space Administration

Major NASA Development Programs

Program Cost Estimates

This special section of the FY 1998 budget justifications provides information about major NASA programs that are either in the design and development phase or have not completed their initial operational phase. In several instances, information about programs which are not "major" but are of special interest has been included. The budgetary estimates are expressed in millions of dollars of *budget authority*. * Estimates of the FY 1996 and prior fiscal year budget authority are the "actual" amounts. The

FY 1997 amounts are consistent with the proposed NASA Operating Plan as of December 1996. The amounts for FY 1998 and future fiscal years are expressed in "real year" economics, that is, they include an adjusting factor for the future inflation expected to be experienced. If the term "constant dollars" is used in the budget justifications, that phraseology indicates that the numbers do not include inflationary adjustments beyond the fiscal year referenced (e.g., "constant FY 1994 dollars").

The estimates provided below are intended to be comprehensive, including all related mission-unique costs, but there are limitations. The direct and indirect costs incurred by foreign governments or other federal agencies in support of these missions have not been included. (The reader is referred to the NASA Program Status Reports, a biannual document published by NASA, for the most accurate information available to NASA on the amounts incurred or to be incurred.) The estimates of civil service costs have been included, but these estimates should be considered preliminary, and they will continue to be refined as the agency moves toward full cost accounting over the next two years.

High Speed Research Program	Mars Pathfinder
Advanced Subsonic Technology	Near-Earth Asteriod Rendezvous (NEAR)
International Space Station	Lunar Prospector
Alternate Turbopump Development	Stardust
Super Lightweight Tank	Mars Surveyor Program
Advanced X-Ray Astrophysics Facility	Mars Global Surveyor
Space Infrared Telescope Facility (SIRTF)	98 Mars Orbiter/Lander
Relativity Mission/Gravity Probe-B	Future Surveyor Missions
Thermosphere, Ionosphere, Mesosphere Energetics and Dynamics (TIMED)	New Millennium Spacecraft
Global Geospace Science Missions	Deep Space I
Collaborative Solar Terrestrial Research Program	Deep Space II
The Explorer Program	Earth Observing System
X-Ray Timing Explorer	Earth Probes
Advanced Composition Explorer	EOS New Millennium Program and Technology Infusion
Far Ultraviolet Spectroscopy Explorer	Scatterometer
Stratospheric Observatory for Infrared Astronomy	Total Ozone Mapping Spectrometer
CASSINI	Tropical Rainfall Measuring Mission
Discovery Missions	TDRS Replenishment Spacecraft Program
X-33 Advanced Technology Demonstrator	

High Speed Research Program

The High Speed Research Program is a cooperative government-industry program to develop the technologies required by U.S. firms to design and build an environmentally compatible and economically competitive high-speed civil transport aircraft for the post-2000 period. The program consists of two phases. Phase I was initiated in FY 1990. Research was initiated at that time into environmental issues, such as atmospheric effects (e.g., ozone depletion), take-off and landing noise levels, and sonic booms for overland flight. Potential technology solutions have also been investigated. Phase II began in FY 1994, following a presentation of the encouraging preliminary results from Phase I activities. This phase involves both government funding and industry contributions of facilities, personnel, and supporting R&D. Development and validation of specific airframe and engine designs, design tools, and technologies for manufacturing processes are underway. This phase will conclude in 2002. It should be noted that the government funding does not provide for the development of a prototype aircraft.

The HSR program previously included the Environmental Research Aircraft and Remote Sensor Technology (ERAST) project element, with the objective of developing the technology for remotely piloted aircraft to serve as platforms to sample the stratospheric atmosphere for exhaust gases and particulates. The technology was not developing fast enough to meet the timelines of HSR, so the ERAST program was replanned to develop and commercialize remotely piloted aircraft. The objectives of ERAST no longer support the primary HSR objectives. ERAST has therefore been transferred from HSR into the R&T base, and the associated funding has been deleted from the HSR program accordingly.

The budgetary estimates provided below are the amounts included in the specific budget justification within the Aeronautics section in the Science, Aeronautics and Technology appropriation for this program. They do not include the amounts being contributed by industry, or for the use of government facilities and general support used to carry out the research. A more detailed exposition of the program goals, objectives and activities is provided in the specific budget justification narrative.

(Budget Authority in Millions of Dollars)										
High Speed Research Program	**PRIOR**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**Balance**	**TOTA**
TOTAL EXCLUDING CIVIL SERVICE COSTS ($M)	658.1	233.3	243.1	245.0	174.0	91.2	60.2	60.2	--	1,765
(ESTIMATED CIVIL SERVICE FTEs)	(1849)	(568)	(573)	(566)	(584)	(514)	(481)	(468)	--	
CIVIL SERVICE COMPENSATION ESTIMATE ($M)	112.7	41.0	44.2	45.9	46.2	41.4	39.7	41.0	--	

Advanced Subsonic Technology

The Advanced Subsonic Technology (AST) program is a cooperative government-industry program to develop technologies in areas where such developments will facilitate the economic and technological competitiveness of U.S. subsonic aircraft producers. These developments include not only airframe, engine, and avionics technology improvements, but also short-haul aircraft, environmental studies, efficiency and safety improvements, advanced air traffic technology, and aircraft design and manufacturing tools. This systems technology program was preceded by activities funded within the research and technology base for many years; the decision to create a focused program was made in the FY 1991 budget**.** The specific objectives set forth for this program are intended to be completed by FY 2004.

In FY 1996, the Fly-by-light/Power-by-Wire (FBL/PBW) element of AST program was terminated and the out-year composite fuselage project was eliminated. Funding for the AST program has been reduced to reflect these changes. In addition, a new change in the AST

activities is provided in the specific budget justification narrative.

(Budget Authority in Millions of Dollars)										
Advanced SubsonicTechnology	**PRIOR**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**Balance**	**TO**
TOTAL EXCLUDING CIVIL SERVICE COSTS ($M)	232.5	169.8	173.6	211.1	187.0	144.2	163.3	94.0	107.1	1,4
(ESTIMATED CIVIL SERVICE FTEs)	(830)	(536)	(597)	(541)	(493)	(443)	(389)	(342)	--	
CIVIL SERVICE COMPENSATION ESTIMATE ($M)	53.4	38.7	46.1	43.9	39.1	35.7	32.1	30.0	--	

International Space Station

In FY 1983, NASA received approval to enter into a preliminary definition phase of a space station. A cost target was established at that time by President Reagan; this target provided guidance to the team undertaking the definition of what capabilities a space station could have for this amount of money. Due to the uncertainty of future inflation, the target was expressed in constant 1984 dollars. The target value of $8 billion was intended to cover the costs which would be incurred to perform the preliminary definition and the development of space station hardware and ground systems. The President also directed NASA to solicit the involvement of international parties in the space station.

After three years studying numerous design concepts, a final reference design was established by NASA and our international partners--Japan, Canada, and the member nations of the European Space Agency. Prior to requesting from the Administration and Congress the authority to proceed into the development phase, NASA undertook a comprehensive cost estimate. The resultant estimate of $14.5 billion (expressed in 1984 dollars for comparison purposes) was presented to the Administration in early 1987. After consideration, the Administration directed a National Research Council (NRC) review of the reference design and the cost estimate. The NRC reported back that the space station could be built in two phases, with the second phase adding the dual keel configuration, the co-orbiting platform, servicing capabilities, and additional solar dynamic power modules. The NRC included in its estimate of $21.0-25.0 billion (1984 dollars), a number of additional cost elements :

operations, marginal Shuttle flight costs, a crew rescue vehicle, civil service salaries and expenses, facilities, and provision for additional testing and backup hardware. These estimates were furnished to the Congress in mid-1987 for their review prior to action on NASA's FY 1988 appropriation.

Over each ensuing year, Congress approved continuation of the Space Station Freedom program, but reduced each year's appropriations request. On several occasions, Congress directed NASA to redesign the Station to conform not only to the reduced appropriations request in that year but also to reduced projections of future funding availability for NASA's overall budget. In early 1993, President Clinton directed NASA to undertake a 90 day study of lower cost redesign options for the Space Station, and appointed an Advisory Committee on the Redesign of the Space Station. In June 1993, upon receiving the final reports and the Advisory Committee's recommendations, President Clinton selected an option (A) from the three options presented and directed NASA to execute the Space Station program for no greater than $2.1 billion per year. This figure encompassed not only the development and operational costs of the Space Station itself but also the costs for a program of precursor scientific research, the expenses for integrating the Space Shuttle and the Space Station and the development of experimental facilities and capabilities for the Space Station. The cap excluded the costs of civil service salaries and expenses, Space Shuttle operational flight costs, and performance improvements to the Shuttle.

In the Fall of 1993, President Clinton invited the Russian Government to become a participant in the program. The Russians offered access to their Mir space station in the interim period between 1995 and the beginning of the international Space Station's

assembly. The Congress and Administration agreed in late 1993 that the $100 million amount to be paid annually to the Russian

Space Agency for hardware and services over the FY 1994-97 period was outside the $2.1 billion annual cap. Since late 1993, the U.S. and the newly expanded set of international partners have proceeded with the final design and hardware development for an international Space Station with significantly greater capabilities for research than those which would have been provided on Space Station Freedom or the option selected in the redesign process.

The budgetary estimates provided below include the amounts for this program in the Human Space Flight appropriation. Previous budgets provided funding for Space Station related research and payloads in the Science, Aeronautics and Technology appropriation. This past year NASA consolidated the management of Space Station research and technology, science utilization, and payload development with the Space Station development and operations program in order to enhance the integrated management of the total content of the annual $2.1 billion budget. The FY 1998 budget reflects that consolidation by funding the total annual $2.1 billion budget within the Space Station budget line of the Human Space Flight appropriation

account. The research and technology elements of the program, including Mir research and support, utilization support, life and microgravity sciences payloads and research, and the station-related space product development activities, are now included in the Research line. The FY 1998 budget proposes multi-year appropriations for the development of the Space Station.

The totals provide the current estimate for the costs to be incurred through the date when the completion of the U.S. element assembly milestone in June 2002 is accomplished. They do not include the amounts being contributed by the international partners, the $400 million contract with the Russian Space Agency, the costs of the non-program unique NASA facilities, Shuttle performance improvements and flight operations costs, and the general and administrative support used to execute the program. The present cost estimate for the average costs of the 18 Space Shuttle flights for assembly of the U.S. elements by June 2002 is $7.4 billion. Four flights largely dedicated to partner elements are estimated at $1.7 billion. An additional 6 Shuttle flights will be made for research and technology utilization purposes during the assembly period; at average costs, these utilization flights are estimated at $2.5 billion. A more detailed exposition of the program goals, objectives and activities is provided in the specific budget justification narrative for the program within the budget justifications for the Space Station.

International Space Station

(Budget Authority in Millions of Dollars)									
International Space Station	**PRIOR**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	
PROGRAM ELEMENTS WITHIN $2.1 BILLION ANNUAL FUNDING CAP	--	**2,106.0**	**2,112.9**	**2,143.6**	**2,148.6**	**2,121.3**	**2,109.2**	**1,914.6**	1
HUMAN SPACE FLIGHT **	**10,234.1**	**2,106.0**	**2,112.9**	**2,143.6**	**2,148.6**	**2,121.3**	**2,109.2**	**1,914.6**	1
SPACE STATION	10,234.1	2,106.0	2,112.9	2,143.6	2,148.6	2,121.3	2,109.2	1,914.6	1
DEVELOPMENT	9,190.4	1,918.2	1,749.4	1,746.2	1,766.3	1,386.1	898.4	651.5	
OPERATIONS	--	--	108.9	120.0	177.6	490.1	714.6	750.6	
RESEARCH	121.0	187.8	254.6	277.4	204.7	245.1	496.2	512.5	
OTHER	922.7	--	--	--	--	--	--	--	
(ESTIMATED CIVIL SERVICE FTEs)	(3,245)	(1,283)	(1,441)	(1,934)	(2,188)	(2,425)	(2,309)	(2,195)	
CIVIL SERVICE COMPENSATION ESTIMATE ($M) ***	164.5	85.9	102.6	139.6	168.8	196.6	182.8	176.7	

Alternate Turbopump Development

Funding to begin development of an alternate design for the two turbopumps driving the Space Shuttle's Main Engine was initiated in FY 1987. The development of a new high-pressure oxygen turbopump and hydrogen fuel turbopump was undertaken to improve the safety, reliability, producibility, and maintainability of the current turbopumps. After an initial period of design and development, problems experienced in early development testing and accompanying increased costs resulted in suspension of the fuel turbopump's development, while development activities concentrated on the oxygen turbopump. Although further development problems were encountered with the oxygen turbopump, their successful resolution led to Congress agreeing in Spring 1994 to resumption of the fuel turbopump's development. The first flight of the oxygen turbopump occurred in 1995, and the initial flight of the fuel pump will be in early FY 1998. The budgetary estimates provided below include not only the funding required for the design, development, and extensive testing of these two types of turbopumps, but also the funding needed to produce the flight turbopumps for installation into the main engines for the four-orbiter fleet. The runout budget estimate of $970.6 million reflects a decrease of $59.8 million from the FY 1997 budget estimate. The decrease is due to a reduction of project reserves, consistent with expected technical progress. The reserves will remain available at the program level, however, should they be required.

The budgetary estimates provided below are the amounts included in the Human Space Flight appropriation for this program. They do not include the amounts for the use of government facilities and general and administrative support used to carry out the development. A more detailed exposition of the program goals, objectives and activities is provided in the specific budget justification narrative for the Space Shuttle program.

(Budget Authority in Millions of Dollars)										
Alternate Turbo Pump Development	**PRIOR**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**Balance**	**TOTAL**
DEVELOPMENT	554.8	68.7	46.7	46.7	22.1	10.8	--	--	--	749.8
IMPLEMENTATION	58.4	28.3	48.7	49.5	28.2	7.7	--	--	--	220.
TOTAL EXCLUDING CIVIL SERVICE COSTS ($M)	613.2	97.0	95.4	96.2	50.3	18.5	--	--	--	970.
(ESTIMATED CIVIL SERVICE FTEs)	(410)	(55)	(51)	(26)	(16)	(16)	--	--	--	-
CIVIL SERVICE COMPENSATION ESTIMATE ($M)	22.5	4.0	3.9	2.1	1.3	1.2	--	--	--	-

Super Lightweight Tank

The design and development of a lighter external tank for the Space Shuttle was undertaken in 1993 after tests of new aluminum-lithium materials indicated that a significantly lighter external tank could be produced. The anticipated weight savings of approximately 7500 pounds would recover some of the ascent performance losses resulting from safety and reliability improvements instituted after the Challenger disaster. Coupled with other performance gains, the super lightweight tank will facilitate the Space Shuttle's operations at

(Budget Authority in Millions of Dollars)										
Super Lightweight Tank	**PRIOR**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**Balance**	**TOTAL**
DEVELOPMENT COST	92.0	30.7	17.5	9.2	6.8	--	--	--	*43.8	200.0
RECURRING COST	28.7	27.3	31.9	33.1	33.1	8.5	--	--	Cont.	162.6
TOTAL EXCLUDING CIVIL SERVICE COSTS ($M)	120.7	58.0	49.4	42.3	39.9	8.5	--	--	43.8	362.6
*- Undistributed reserve										
(ESTIMATED CIVIL SERVICE FTEs)	(73)	(78)	(68)	(64)	(37)	(43)	--	--	--	--
CIVIL SERVICE COMPENSATION ESTIMATE ($M)	5.2	5.6	5.3	5.2	2.9	3.5	--	--	--	--

Advanced X-Ray Astrophysics Facility

The design and development of the Advanced X-Ray Astrophysics Facility (AXAF) was approved by Congress in the FY 1989 budget. The AXAF is the third of the four "Great Observatories" intended to observe the universe in four electromagnetic spectrum regions: visible, infrared, gamma ray, and x-ray. The initial phase of the AXAF's development was limited to a feasibility demonstration of the new mirror technology required to achieve the AXAF's objectives. A specially designed x-ray calibration facility was constructed to assure the mirrors meet their design specifications. The second phase was approved by Congress after the demonstration mirrors were successfully tested. In 1992, NASA management directed the restructuring of the AXAF program to reduce projected future funding requirements. A two-spacecraft approach was selected, a large imaging spacecraft (**AXAF-I**maging) and a smaller spectroscopy spacecraft (**AXAF-S**pectroscopy). In 1993, Congress directed the elimination of the AXAF-S. The launch of the AXAF-I spacecraft is scheduled for September 1998 aboard the Space Shuttle, with an Inertial Upper Stage (IUS) providing delivery into a highly elliptical orbit around the Earth. The budgetary estimates provided below encompass: the early development of the mirror technology; the design and development phase; establishment of a mission-unique science center and preflight ground

system development, followed by a five-year period (1998-2002) of mission operations and science data analysis; the purchase of the IUS and integration activities; the average cost (including recurring costs for improvements and upgrades) of an FY 1998 Space Shuttle flight; mission-unique tracking and data support costs; and, the construction of the X-Ray Calibration Facility.

The estimates provided below include a pro forma distribution of the average costs of a Space Shuttle. They do not include the amounts being contributed by international participants, or for the use of non-program-unique government facilities and general and administrative support used to carry out the research and development activities. A more detailed exposition of the program goals, objectives and activities is provided in the specific budget justification narrative for the program within the Space Science section.

(Budget Authority in Millions of Dollars)										
Advanced X-Ray Astrophysics Facility	**PRIOR**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**BTC**	**TOTAL**
ADVANCED TECH DEVELOPMENT	54.2	--	--	--	--	--	--	--	--	54.2
DEVELOPMENT	943.8	237.6	178.6	92.2	--	--	--	--	--	1,452.2
MISSION OPS & DATA ANALYSIS	52.5	40.4	41.3	45.4	63.6	63.3	67.3	69.9	76.3	520.0
UPPER STAGE	32.6	15.3	14.5	5.3	--	--	--	--	--	67.7
STS LAUNCH SUPPORT	--	216.7	86.6	130.0	--	--	--	--	--	433.3
TRACKING & DATA SUPPORT	.3	.5	.4	.3	.2	.2	.2	.2	1.4	3.7
CONSTRUCTION OF FACILITIES	17.7	--	--	--	--	--	--	--	--	17.7
TOTAL EXCLUDING CIVIL SERVICE COSTS ($M)	1,101.1	510.5	321.4	273.2	63.8	63.5	67.5	70.1	77.7	2,548.8
(ESTIMATED CIVIL SERVICE FTEs)	--	(1052)	(269)	(235)	(183)	(70)	(36)	(36)	(36)	--
CIVIL SERVICE COMPENSATION ESTIMATE ($M)	--	61.5	19.4	18.1	14.8	5.5	2.9	3.0	3.2	--

restructuring of the SIRTF design concept carried for many years. Rather than simply "descoping" the "Great Observatory" concept to fit within a $400 million (FY94 $) cost ceiling imposed by NASA, scientists and engineers have instead redesigned SIRTF from the bottom-up. The goal was to substantially reduce costs associated with every element of SIRTF -- the telescope, instruments, spacecraft, ground system, mission operations, and project management. The Jet Propulsion Laboratory (JPL) was assigned responsibility for managing the SIRTF project. SIRTF is planned for launch on a Delta launch vehicle during FY 2002. The FY 1998 budget proposes multi-year appropriations for development of SIRTF. This will ensure the stability to manage and execute this program within its budget and schedule commitments.

The budgetary estimates below are the amounts included in the Science, Aeronautics and Technology appropriation for this program. They do not include the amounts for the definition phase studies carried out prior to FY 96. A more detailed exposition of the program goals, objectives and activities is provided in the specific budget justification narrative for the program within the Space Science section.

(Budget Authority in Millions of Dollars)										
Space Infrared Telescope Facility (SIRTF)	**PRIOR**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**BTC**	**TOTAL**
ATD	--	15.0	24.9	--	--	--	--	--	--	39.9
DEVELOPMENT	--	--	--	81.4	126.5	108.1	97.6	19.2	--	432.8
MISSION OPS & DATA ANALYSIS	--	--	--	--	--	--	--	20.0	101.2	121.2
LAUNCH SUPPORT	--	--	--	--	8.0	21.9	19.7	6.6	--	56.2
TRACKING & DATA SUPPORT	--	--	--	--	--	--	--	--	--	TBD
TOTAL EXCLUDING CIVIL SERVICE COSTS ($M)	--	15.0	24.9	81.4	134.5	130.0	117.3	45.8	101.2	650.1
(ESTIMATED CIVIL SERVICE FTEs)	--	--	(3)	(2)	(2)	(2)	(2)	(2)	(2)	--
CIVIL SERVICE COMPENSATION ESTIMATE ($M)	--	--	0.2	0.2	0.2	0.2	0.2	0.2	0.2	--

a ground test program only. The estimates also exclude the non-program-unique government facilities and general and administrative support used to carry out the research and development activities. A more detailed exposition of the program goals, objectives and activities is provided in the specific budget justification narrative for the program within the Space Science section.

(Budget Authority in Millions of Dollars)										
Relativity Mission/Gravity Probe-B	**PRIOR**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**BTC**	**TOTAL**
DEVELOPMENT	219.8	51.5	59.6	45.6	44.0	35.8	4.1	--	--	460.4
MISSION OPS & DATA ANALYSIS	--	--	--	--	--	--	20.8	--	--	20.8
LAUNCH SUPPORT	--	--	6.8	14.7	18.8	16.7	.2	--	--	57.2
TRACKING & DATA SUPPORT	--	--	--	--	--	--	TBD	--	--	TBD
TOTAL EXCLUDING CIVIL SERVICE COSTS ($M)	219.8	51.5	66.4	60.3	62.8	52.5	25.1	--	--	538.4
(ESTIMATED CIVIL SERVICE FTEs)	(62)	(15)	(13)	(13)	(13)	(12)	(12)	--	--	--
CIVIL SERVICE COMPENSATION ESTIMATE ($M)	3.5	1.1	1.0	1.1	1.0	1.0	1.0	--	--	--

Thermosphere, Ionosphere, Mesosphere Energetics and Dynamics (TIMED)

The TIMED mission is the first science mission in the Solar Terrestrial Probes (STP) Program, and is part of NASA's initiative aimed at providing cost-efficient scientific investigation and more frequent access to space. The development cost for the TIMED mission is capped at $100 million in FY 1994 dollars. TIMED will be developed for NASA by the Johns Hopkins University Applied Physics Laboratory (APL). The Aerospace Corporation, the University of Michigan, NASA's Langley Research Center with the Utah State University's Space Dynamics Laboratory, and the National Center for Atmospheric Research will provide instruments for the TIMED mission.

TIMED is scheduled for launch in January 2000 aboard a Med-Lite Class launch vehicle. TIMED will begin its 36-month C/D development period in April 1997. The budgetary estimates below are the amounts included in the Science, Aeronautics and Technology appropriation for this program. They do not include the amounts for the definition phase studies carried out from April 1996 to April 1997.

(Budget Authority in Millions of Dollars)										
Thermosphere, Ionosphere, Mesosphere Energetics and Dynamics (TIMED	**PRIOR**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**BTC**	**TOTAL**
DEVELOPMENT	--	--	18.2	48.2	47.3	15.6	--	--	7.2	129.3
MISSION OPS & DATA ANALYSIS	--	--	--	--	--	6.1	--	--	--	--
LAUNCH SUPPORT	--	--	--	8.7	11.5	9.2	--	--	--	26.3
TOTAL EXCLUDING CIVIL SERVICE COSTS ($M)	--	--	18.2	56.9	58.8	30.9	12.8	9.0	7.2	193.8
(ESTIMATED CIVIL SERVICE FTEs)	--	(7)	(14)	(19)	(19)	(18)	(8)	(8)	--	--
CIVIL SERVICE COMPENSATION ESTIMATE ($M)	--	0.5	1.1	1.5	1.5	1.5	0.7	0.8	--	--

Global Geospace Science Missions

The development of the two Global Geospace Science (GGS) missions was approved by Congress in the budget for 1989**.** The Wind and Polar spacecraft are parts of a coordinated international science program to improve our understanding of the complex interactions between the sun and the Earth. Nineteen instruments aboard the two spacecraft will make measurements of the interaction between the solar wind with the Earth's magnetic field. The

Wind spacecraft was launched successfully on a Delta II launch vehicle in November 1994. The Polar spacecraft was launched successfully in February 1996, also on a Delta II. The budgetary estimates provide for the experiment and spacecraft development, a 2.5-year period of mission operations**,** the launch services, and unique tracking and data acquisition support required during the mission.

The budgetary estimates provided below are the amounts included in the Science, Aeronautics and Technology appropriation for this program. They do not include the amounts being contributed by international participants, or for the use of non-program-unique government facilities and general and administrative support used to carry out the research and development activities. A more detailed exposition of the program goals, objectives and activities is provided in the specific budget justification narrative for the program within the Space Science section.

(Budget Authority in Millions of Dollars)										
Global Geospace Science Missions	**PRIOR**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**Balance**	**TOTAL**
DEVELOPMENT	452.7	--	--	--	--	--	--	--	--	452.7
MISSION OPS & DATA ANALYSIS	17.2	26.5	25.5	15.7	--	--	--	--	--	84.9
LAUNCH SUPPORT	116.6	3.0	--	--	--	--	--	--	--	119.6
TRACKING & DATA SUPPORT	26.1	0.6	0.1	0.1	0.1	--	--	--	--	27.0
TOTAL EXCLUDING CIVIL SERVICE COSTS ($M)	612.6	30.1	25.6	15.8	0.1	--	--	--	--	684.2
(ESTIMATED CIVIL SERVICE FTEs)	(684)	(22)	(5)	(10)	(10)	--	--	--	--	--
CIVIL SERVICE COMPENSATION ESTIMATE ($M)	38.7	1.6	0.4	0.8	0.8	--	--	--	--	--

Collaborative Solar Terrestrial Research Program

The Collaborative Solar Terrestrial Research (COSTR) program is another key U.S. contribution to the international solar terrestrial research program. Beginning in FY 1987, funding provided for this program has enabled NASA to provide instruments and launch support for international spacecraft. In return, the U.S. obtains access to the science data collected by the five European Space Agency spacecraft and one Japanese spacecraft. The initial launch was carried out in July 1992 with the launch of the Japanese Geotail spacecraft on a U.S.-funded Delta II. The December 1995 launch of the ESA Solar and Heliospheric Observatory (SOHO) was on a U.S.-funded Atlas IIAS. Mission operations and data analysis provides for spacecraft operations, the operations support to the U.S. furnished instruments and the analysis of the scientific data gathered by them.

The four Cluster spacecraft were launched in May 1996, on an Ariane V; however the launch failed and the payload was lost. Options for recovery of the Cluster mission science are under review by NASA and ESA.

The budgetary estimates provided below are the amounts included in the Science, Aeronautics and Technology appropriation for this program. They do not include the amounts being contributed by international participants, and the use of non-program-unique government facilities and general and administrative support used to carry out the research and development activities. A more detailed exposition of the program goals, objectives and activities is provided in the specific budget justification narrative for the program within the Space Science section.

(Budget Authority in Millions of Dollars)										
Collaborative Solar Terrestrial Research Program	**PRIOR**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**Balance**	**TOTAL**
DEVELOPMENT	331.0	--	--	--	--	--	--	--	--	331.0
MISSION OPS & DATA ANALYSIS	28.9	31.9	28.4	8.5	--	--	--	--	--	97.7
LAUNCH SUPPORT	176.1	--	--	--	--	--	--	--	--	176.1
TRACKING & DATA SUPPORT	38.8	1.2	0.1	0.1	--	--	--	--	--	40.2
TOTAL EXCLUDING CIVIL SERVICE COSTS ($M)	574.8	33.1	28.5	8.6	--	--	--	--	--	645.0
(ESTIMATED CIVIL SERVICE FTEs)	(446)	(25)	(26)	(24)	(14)	(12)	--	--	--	--
CIVIL SERVICE COMPENSATION ESTIMATE ($M)	25.2	1.8	2.0	1.9	1.1	1.0	--	--	--	--

(Budget Authority in Millions of Dollars)										
The Explorer Program	**PRIOR**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**BTC**	**TOTA**
X-Ray Timing Explorer	253.1	11.6	10.2	7.3	4.8	3.3	--	--	--	290
Advanced Composition Explorer	110.2	33.7	35.9	12.6	7.5	7.7	3.7	3.9	--	215
Far Ultraviolet Spectroscopy Explorer	.5	70.8	22.6	42.1	9.6	9.4	9.4	7.0	--	171
Medium Explorers	--	13.7	45.2	62.4	87.8	103.3	101.8	118.5	CONT	
Small Explorers	--	50.8	59.7	56.8	65.7	74.5	85.5	86.8	CONT	-
University Explorers	--	12.3	7.1	13.3	11.8	8.3	6.5	10.6	CONT	
Planning & Future Developments	--	6.7	5.7	6.0	8.3	5.3	4.9	5.6	CONT	
TOTAL EXCLUDING CIVIL SERVICE COSTS ($M)	--	199.6	186.4	200.5	195.5	211.8	211.8	232.4	CONT	
(ESTIMATED CIVIL SERVICE FTEs)	(1,248)	(100)	(97)	(85)	(79)	(78)	(78)	(78)	(Cont.)	
CIVIL SERVICE COMPENSATION ESTIMATE ($M)	71.8	7.2	7.5	6.9	6.3	6.3	6.4	6.8	Cont.	

X-Ray Timing Explorer

Development on the X-Ray Timing Explorer (XTE) began in FY 1990. The spacecraft was an in-house build at the Goddard Space Flight Center; instruments were developed by the principal investigators. The XTE was launched successfully in December 1995 on a Delta II launch vehicle.

(Budget Authority in Millions of Dollars)										
X-Ray Timing Explorer	**PRIOR**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**Balance**	**TOTAL**
DEVELOPMENT	194.2	--	--	--	--	--	--	--	--	194.2
MISSION OPS & DATA ANALYSIS	1.0	10.0	9.9	7.0	4.8	3.3	--	--	--	36.0
LAUNCH SUPPORT	45.5	--	--	--	--	--	--	--	--	45.5
TRACKING & DATA SUPPORT	12.4	1.6	0.3	0.3	--	--	--	--	--	14.6
TOTAL	253.1	11.6	10.2	7.3	4.8	3.3	--	--	--	290.3

Advanced Composition Explorer

Development on the Advanced Composition Explorer (ACE) began in FY 1994. The spacecraft is being built by the Johns Hopkins Applied Physics Lab; instruments are being managed by the California Institute of Technology. ACE is scheduled for launch between August 1997 and December 1997 on a Delta II launch vehicle.

(Budget Authority in Millions of Dollars)										
Advanced Composition Explorer	**PRIOR**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**BTC**	**TOTAL**
DEVELOPMENT	77.3	18.5	18.7	5.5	--	--	--	--	--	120.0
MISSION OPS & DATA ANALYSIS	--	--	1.6	6.3	7.2	7.4	3.6	3.8	--	29.9
LAUNCH SUPPORT	28.6	10.9	12.0	--	--	--	--	--	--	51.5
TRACKING & DATA SUPPORT	4.3	4.3	3.6	.8	.3	.3	.1	.1	--	13.8
TOTAl	110.2	33.7	35.9	12.6	7.5	7.7	3.7	3.9	--	215.2

Far Ultraviolet Spectroscopic Explorer

Development on the Far Ultraviolet Spectroscopy Explorer (FUSE) began in FY 1996. The FUSE mission has been restructured from a Delta-class explorer in order to reduce costs and accelerate the launch date from CY 2000 to November 1998. FUSE is being managed by Johns Hopkins University, with contributions from the University of Colorado, the University of California-Berkeley, Orbital Sciences Corp., Canada and France.

(Budget Authority in Millions of Dollars)										
Far Ultraviolet Spectroscopic Explorer	**PRIOR**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**BTC**	**TOTAL**
DEVELOPMENT	--	56.6	22.0	26.8	2.6	--	--	--	--	108.0
MISSION OPS & DATA ANALYSIS	--	--	--	--	7.0	9.4	9.4	7.0	--	32.8
LAUNCH SUPPORT	.5	14.2	.6	15.3	--	--	--	--	--	30.6
TOTAL	.5	70.8	22.6	42.1	9.6	9.4	9.4	7.0	--	171.4

Stratospheric Observatory for Infrared Astronomy

The initial development funding for the Stratospheric Observatory for Infrared Astronomy (SOFIA) was requested in the

FY 1996 budget. This new airborne observatory will provide a significant increase in scientific capabilities over the Kuiper Airborne Observatory, which was retired in October, 1995. The Kuiper was a Lockheed C-141A aircraft with a 0.9-meter reflecting telescope, used to conduct scientific investigations at infrared and submillimeter wavelengths. The SOFIA will be accommodated in a Boeing 747 and will feature a 2.5-meter infrared telescope to be provided by the German Space Agency (DARA). The initial operational date for SOFIA will be at the end of 2000. The FY 1998 budget proposes multi-year appropriations for development of SOFIA. This will ensure the stability to manage and execute this program within its budget and schedule commitments.

The budget estimates provided below are the amounts included in the Science, Aeronautics and Technology appropriation for this program. They do not include the costs of preliminary design studies carried out in previous years, the amounts being contributed by the international participants, or costs for the use of government facilities and general and administrative support used to carry out the research and development activities. A more detailed exposition

of the program goals, objectives and activities is provided in the specific budget justification narrative for the Suborbital program within the Space Science section.

(Budget Authority in Millions of Dollars)										
Stratospheric Observatory for Infrared Astronomy	**PRIOR**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**BTC**	**TOTAL**
DEVELOPMENT	--	30.0	21.3	45.8	56.5	48.8	32.4	--	--	234.8
MISSION OPERATIONS	--	--	--	--	--	--	--	36.6	CONT.	CONT.
TOTAL EXCLUDING CIVIL SERVICE COSTS	--	30.0	21.3	45.8	56.5	48.8	32.4	36.6	--	--
(ESTIMATED CIVIL SERVICE FTEs)	(6)	(13)	(15)	(15)	(15)	(15)	(15)	(10)	--	--
-CIVIL SERVICE COMPENSATION ESTIMATE ($M)	0.5	0.9	1.1	1.2	1.2	1.2	1.2	0.9	--	--

CASSINI

The Cassini mission will provide intensive, long term observations of Saturn's atmosphere, rings, magnetosphere and moons. The Huygens Probe will conduct direct physical and chemical analyses of the atmosphere of Saturn's moon, Titan. Cassini was approved as a new start by Congress in the FY 1990 budget. At the time it was initiated, a second spacecraft, the Comet Rendezvous and Asteroid Flyby (CRAF) was included. Congressionally-imposed reductions to FY 1992-93 funding requirements led to the termination of the CRAF mission and the deferral of the Cassini launch from April 1996 to October 1997. The Cassini program later underwent a significant redesign in early 1992 to reduce total program cost, mass and power requirements, while maintaining the October 1997 launch aboard a Titan IV launch vehicle. The spacecraft will arrive at Saturn in 2004 and begin a four year study of the Saturnian system. The program involves significant cooperation from international partners as well as U.S. government partners. The European Space Agency is providing the Huygens Probe and the Italian Space Agency is contributing the High Gain/Low Gain antenna for the

spacecraft. There are twelve science instruments on the orbiter and six on the probe from international Principal Investigators. The Titan IV launch vehicle is being procured from the Department of Defense, and the Radioisotope Heater Units (RHUs) and Radioisotope Thermoelectric Generators (RTGs) are being procured by NASA from the Department of Energy.

The budgetary estimates provided below are the amounts included in the Science, Aeronautics and Technology appropriation for this program. They do not include the amounts being contributed by the international participants, or for the use of government facilities and general and administrative support required to implement the program. A more detailed description of the program goals, objectives and activities is provided in the specific budget justification narrative for the program within the Space Science section.

(Budget Authority in Millions of Dollars)										
CASSINI	**PRIOR**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**BTC**	**TOTAL**
DEVELOPMENT	1,109.8	191.5	89.6	9.0	--	--	--	--	--	1,399.9
MISSION OPS & DATA ANALYSIS	--	--	--	38.1	55.8	55.0	56.6	63.8	466.7	736.0
LAUNCH SUPPORT	206.1	88.2	95.2	39.6	--	--	--	--	--	429.1
TRACKING & DATA SUPPORT	19.6	1.8	3.0	4.7	8.8	6.2	4.5	5.0	--	53.6
TOTAL EXCLUDING CIVIL SERVICE COSTS ($M)	1,335.5	281.5	187.8	91.4	64.6	61.2	61.1	68.8	466.7	2,618.6
(ESTIMATED CIVIL SERVICE FTEs)	(389)	(84)	(24)	(3)	(3)	(3)	(3)	(3)	--	--
CIVIL SERVICE COMPENSATION ESTIMATE ($M)	23.7	6.1	1.9	0.2	0.2	0.2	0.2	0.3	--	--

Discovery Missions

Discovery missions are planetary exploration missions designed with focused science objectives that can be met with limited resources. Total development costs are not to exceed

$150 million in constant FY 1992 dollars, and development schedules are limited to three years or less. Two Discovery missions have been launched: NEAR in February 1996 and Mars Pathfinder in December 1996. In addition, there are two approved Discovery missions in development: the Lunar Prospector and Stardust. Future missions will be undertaken after selection through a peer review process.

The budgetary estimates provided below are the amounts included in the specific budget justification for this program within the Space Science section in the Science, Aeronautics and Technology appropriation. Under the specific mission descriptions, see below, other direct program cost elements are included: the development of the spacecraft and experiments, one year of mission operations, the launch services, and unique tracking and data acquisition services. They do not include costs for the use of government facilities and general and administrative support required to implement the program. A more detailed description of the program goals, objectives and activities is provided in the specific budget justification narrative for the program.

(Budget Authority in Millions of Dollars)										
Discovery Missions	**PRIOR**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**BTC**	**TOTA**
NEAR	156.7	16.9	1.6	9.7	15.0	8.8	.2	.3	--	209.
MARS PATHFINDER	188.8	55.8	15.0	6.0	.1	--	--	--	--	265
LUNAR PROSPECTOR	--	36.4	20.6	4.3	2.2	.0	.0	.0	.0	63
STARDUST	--	27.7	62.7	56.2	23.9	3.4	3.3	3.3	25.6	206.
FUTURE MISSIONS DEVELOPMENT	--	.7	4.8	64.2	120.7	127.5	132.6	137.6	CONT	
FUTURE MISSIONS MO&DA	--	--	--	--	3.2	9.4	11.0	11.4	CONT	
FUTURE MISSIONS ELVs	--	--	--	6.0	19.6	36.5	43.5	67.2	CONT	
TOTAL	--	137.5	104.7	146.4	184.7	185.6	190.6	219.8	CONT	
(ESTIMATED CIVIL SERVICE FTEs)	(31)	(2)	(7)	(7)	(7)	(7)	(7)	(7)	(Cont.)	
CIVIL SERVICE COMPENSATION ESTIMATE ($M)	2.2	0.1	0.5	0.6	0.6	0.6	0.6	0.6	Cont.	

(Budget Authority in Millions of Dollars)										
Mars Pathfinder	**PRIOR**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**Balance**	**TOTAL**
DEVELOPMENT	140.5	33.7	--	--	--	--	--	--	--	174.2
MICROROVER	17.2	5.8	2.0	--	--	--	--	--	--	25.0
MISSION OPS & DATA ANALYSIS	--	--	9.6	5.8	0.1	--	--	--	--	15.5
LAUNCH SUPPORT	31.0	16.1	3.2	--	--	--	--	--	--	50.3
TRACKING & DATA SUPPORT	0.1	0.2	0.2	0.2	--	--	--	--	--	0.7
TOTAL	188.8	55.8	15	6.0	2.0	--	--	--	--	265.7

Near-Earth Asteroid Rendezvous (NEAR)

The NEAR was approved as a new start in FY 1994 as one of the initial Discovery Program missions. The NEAR mission was conducted as an in-house effort at the Applied Physics Laboratory, with many subcontracted subsystems. The NEAR spacecraft will conduct a comprehensive study of the near-Earth asteroid 433 EROS, including its physical and geological properties and its chemical and mineralogical composition. The NEAR spacecraft was launched February 17,1996 on a Delta II launch vehicle.

(Budget Authority in Millions of Dollars)										
Near-Earth Asteroid Rendezvous (NEAR)	**PRIOR**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**Balance**	**TOTAL**
DEVELOPMENT	116.6	8.3	--	--	--	--	--	--	--	124.9
MISSION OPS & DATA ANALYSIS	--	4.9	1.4	9.5	14.8	8.6	--	--	--	39.2
LAUNCH SUPPORT	40.0	3.5	--	--	--	--	--	--	--	43.5
TRACKING & DATA SUPPORT	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.3	--	1.6
TOTAL	156.7	16.9	1.6	9.7	15.0	8.8	0.2	0.3	--	209.2

Lunar Prospector

Lunar Prospector was selected as the third Discovery mission in FY 1995, and Phase C/D development started in the first quarter of FY 1996. The mission is designed to search for resources on the Moon, with special emphasis on the search for water in the shaded polar regions. Ames Research Center is managing the mission, and Lockheed Martin will provide the spacecraft, instruments, launch and operations. Launch will be on a Lockheed Launch Vehicle-II (LLV-II) and is planned for September 1997. Launch costs are included in the development cost. Tracking and communications support will be provided by the Deep Space

The Stardust mission was selected as the fourth Discovery mission in November 1995, with mission management from the Jet Propulsion Laboratory. The mission team has completed the Phase B analysis, and Stardust was approved for implementation in October, 1996. The mission is designed to gather samples of dust from the comet Wild-2 and return the samples to Earth for detailed analysis. The mission will also gather and return samples of interstellar dust that the spacecraft encounters during its trip through the Solar System to fly by the comet. Stardust will use a new material called aerogel to capture the dust samples. In addition to the aerogel collectors, the spacecraft will carry three additional scientific instruments. An optical camera will return images of the comet; the Cometary and Interstellar Dust Analyzer (CIDA) is provided by Germany to perform basic compositional analysis of the samples while in flight; and a dust flux monitor will be used to sense particle impacts on the spacecraft. Stardust will be launched on the Med-Lite expendable launch vehicle in February 1999 with return of the samples to Earth in January 2006.

(Budget Authority in Millions of Dollars)										
Stardust	**PRIOR**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**BTC**	**TOTAL**
PHASE A/B	--	9.6	--	--	--	--	--	--	--	9.6
DEVELOPMENT	--	13.5	52.2	42.3	9.8	--	--	--	--	117.8
MISSION OPS & DATA ANALYSIS	--	--	--	--	1.6	3.4	3.3	3.3	25.6	37.2
LAUNCH SUPPORT	--	4.6	10.5	13.9	12.5	--	--	--	--	41.5
TOTAL	--	27.7	62.7	56.2	23.9	3.4	3.3	3.3	25.6	206.1

Mars Surveyor Program

The Mars Surveyor program is a series of small missions designed to resume the detailed exploration of Mars. The first mission in this program, the Mars Global Surveyor mission, was approved as a new start in FY 1994. The follow-on Mars Surveyor 98 Orbiter and Lander were approved in FY 1995. Future small missions are targeted for launch in the launch windows that occur approximately every two years.

The budgetary estimates below are the amounts indicated in the budget justification within the Space Science section in the Science, Aeronautics and Technology appropriation. The specific write-ups for the Mars Global Surveyor and Mars 98 Orbiter/Lander missions include the amounts for the development of the spacecraft and instruments, two years of mission operations, and launch services. They do not include costs for the use of government facilities

and general and administrative support used to carry out the program. A more detailed description of the program goals, objectives and activities is provided in the specific budget justification narrative.

(Budget Authority in Millions of Dollars)										
Mars Surveyor Program	**PRIOR**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**Balance**	**TO**
MARS GLOBAL SURVEYOR	94.8	82.9	23.1	19.9	10.6	--	--	--	--	
98 MARS ORBITER/LANDER	--	59.8	116.7	79.3	30.9	21.7	22.2	22.7	--	
FUTURE MISSIONS	--	1.4	3.1	103.3	151.6	212.1	215.4	214.7	Cont.	9
TOTAL EXCLUDING CIVIL SERVICE COSTS ($M)	94.8	145.1	142.9	202.5	193.1	233.8	237.6	237.4	--	1
(ESTIMATED CIVIL SERVICE FTEs)	(37)	(6)	(8)	(7)	(7)	(7)	(7)	(7)	(Cont.)	
CIVIL SERVICE COMPENSATION ESTIMATE ($M)	2.6	0.4	0.6	0.6	0.6	0.6	0.6	0.6	Cont.	

Mars Global Surveyor

This mission will obtain a majority of the expected science return from the lost Mars Observer mission by flying a science payload comprised of spare Mars Observer instruments aboard a small, industry-developed spacecraft. Launch occurred in November 1996 on a Delta II launch vehicle. The funding estimates provided below do not include the previous expenditures on spare Mars Observer instruments or the amount recovered from the prime contractor after the Mars Observer failure.

(Budget Authority in Millions of Dollars)										
Mars Global Surveyor	**PRIOR**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**Balance**	**TOTAL**
DEVELOPMENT	72.6	58.1	--	--	--	--	--	--	--	130.7
MISSION OPS & DATA ANALYSIS	--	--	16.4	19.6	10.4	--	--	--	--	46.4
LAUNCH SUPPORT	21.8	24.4	6.4	--	--	--	--	--	--	52.6
TRACKING & DATA SUPPORT	0.4	0.4	0.3	0.3	0.2	--	--	--	--	1.6
TOTAL	94.8	82.9	23.1	19.9	10.6	--	--	--	--	231.3

98 Mars Orbiter/Lander

The 98 Mars Orbiter and Lander are the first follow-on missions in the Mars Surveyor program. The Orbiter will be launched on a Med-Lite launcher in December 1998, and the Lander will be launched on a Med-Lite in January 1999. Lockheed Martin Aerospace, Denver, was selected competitively to develop these spacecraft. The Orbiter will carry a color imager and a Pressure Modulater Infrared Radiometer (PMIRR), which was also a Mars Observer payload. The Lander will carry a descent imager, a comprehensive volatiles and climate payload, and a Russian LIDAR atmospheric instrument.

(Budget Authority in Millions of Dollars)										
98 Mars Orbiter/Lander	**PRIOR**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**Balance**	**TOTAL**
DEVELOPMENT	--	52.4	86.9	40.5	13.3	--	--	--	--	193.1
MISSION OPS & DATA ANALYSIS	--	--	--	--	10.3	21.3	21.9	22.7	--	76.2
LAUNCH SUPPORT	--	7.4	29.8	38.8	7.1	--	--	--	--	83.1
TRACKING & DATA SUPPORT	--	--	--	--	0.2	0.4	0.3	--	--	0.9
TOTAL	--	59.8	116.7	79.3	30.9	21.7	22.2	22.7	--	353.3

Future Surveyor Missions

The Mars Surveyor landers planned in future years -- 2001, 2003 and beyond -- will capitalize on the experience of the Mars Pathfinder lander mission launched in November 1996. The small orbiter to be launched in 2003 will draw on the experience of Mars Global Surveyor and carry other scientific instruments into orbit to complete Mars Global Surveyor's science missions. A Mars sample return mission is being considered for the FY 2005 opportunity.

(Budget Authority in Millions of Dollars)										
Future Surveyor Missions	**PRIOR**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**BTC**	**TOTAL**
DEVELOPMENT	--	1.4	3.1	99.2	122.7	167.7	170.3	173.9	--	738.3
MISSION OPS & DATA ANALYSIS	--	--	--	--	--	--	--	--	--	--
LAUNCH SUPPORT	--	--	--	4.1	28.9	44.4	45.1	40.8	CONT	--
TRACKING & DATA SUPPORT	--	--	--	--	--	--	--	--	TBD	TBD
TOTAL	--	1.4	3.1	103.3	151.6	212.1	215.4	214.7	--	--

Space Science New Millennium Spacecraft

The New Millennium program is an advanced development effort started in FY 1996 to demonstrate how complex scientific spacecraft--such as those required for planetary missions--can be built for lower mission costs and have short development times, while still possessing considerable scientific merit. The New Millennium Spacecraft program will enable the introduction of the latest technology advances into spacecraft for planetary and outer solar system explorations. The primary objectives of the program are to increase the performance capabilities of spacecraft and instruments while simultaneously reducing total costs of future science missions, thereby allowing more frequent flight opportunities even under the severe budget constraints of the future. In previous years, NASA and the Department of Defense have funded technology developments which offer extraordinary promise. This precursor work on technologies can now be demonstrated in a series of flight technology demonstration missions occurring at a rate of one every 1.5 years, with the initial flight planned for the mid-1998 time frame.

The budgetary estimates below represent funding included in the Science, Aeronautics and Technology appropriation. The program is designed as an ongoing program, and funding is included for development and launch of one mission per every one and one half years, beginning in 1998. Launches are generally targeted for small expendable launch vehicles. The budget estimate below does not include the costs for the government facilities and general and administrative support used to carry out the research and development activities. Additional information on the first two missions is provided later in this section. A more detailed description of the program goals, objectives and activities is provided in the specific budget justification narrative for the program.

(Budget Authority in Millions of Dollars)									
Space Science New Millennium Spacecraft	**PRIOR**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**Balance**
ADVANCED TECH DEVELOPMENT	10.5	--	--	--	--	--	--	--	--
NEW MILLENNIUM DEVELOPMENT	--	43.5	45.6	30.7	51.4	52.9	49.3	59.0	Cont.
OUTER PLANET TECHNOLOGY	--	--	--	25.0	25.0	50.0	50.0	50.0	Cont.
ADVANCED RTG	--	--	3.0	10.0	10.0	10.0	10.0	10.0	Cont.
CTR FOR INTEG SPACE MICROSYSTEMS	--	--	--	10.0	15.0	15.0	15.0	15.0	Cont.
LAUNCH SUPPORT	--	3.7	5.1	32.9	10.6	12.4	9.6	24.8	Cont.
TOTAL EXCLUDING CIVIL SERVICE COSTS ($M)	10.5	47.2	53.7	108.6	112.0	140.3	133.9	158.8	Cont.
(ESTIMATED CIVIL SERVICE FTEs)	--	(2)	(4)	(4)	(4)	(4)	(4)	(4)	Cont.
CIVIL SERVICE COMPENSATION ESTIMATE ($M)	--	0.1	0.3	0.3	0.3	0.3	0.3	0.4	--

Deep Space I

Deep Space I was selected in FY 1996 as the first New Millennium Program mission. The technology to be validated will include solar electric propulsion, an advanced solar array, autonomous primary navigation, 3-D stack flight computer, and miniature imaging camera spectrometer. Spectrum Astro was selected in FY 1996 to integrate the spacecraft. DS I is expected to launch in July, 1998 on a Med-Lite-class Delta launch vehicle. The supplemental technology development line below contains funding for crosscutting technology development efforts previously managed by the Office of Space Access and Technology.

(Budget Authority in Millions of Dollars)										
Deep Space I	**PRIOR**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**BTC**	**TOTAL**
DEVELOPMENT	--	26.3	28.9	18.1	--	--	--	--	--	73.3
SUPPLEMENTAL TECH DEV	--	7.2	6.1	1.6	--	--	--	--	--	14.9
MISSION OPS & DATA ANALYSIS	--	--	--	--	3.6	2.1	--	--	--	5.7
LAUNCH SUPPORT	--	3.7	5.1	31.9	--	--	--	--	--	40.7
TRACKING & DATA SUPPORT	--	--	0.1	0.2	0.1	--	--	--	--	0.4
TOTAL	--	37.2	40.2	51.8	3.7	2.1	--	--	--	135.0

Deep Space II

Deep Space II was selected in FY 1996 as the second of the series of missions under the New Millennium Program. DS II is designed to develop and validate technologies and systems required to deliver multiple small packages to the surface and/or subsurface of Mars using direct entry. Some of the technologies to be validated include a microtelecommunications system, power electronics, a microcontroller, flexible interconnects for system cabling, a meteorological, high-g pressure sensor, and a sample/water experiment. DS II will be attached to ("piggyback" on) the Mars 98 Lander, which is scheduled to launch in January 1999.

(Budget Authority in Millions of Dollars)										
Deep Space II	**PRIOR**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**BTC**	**TOTAL**
DEVELOPMENT	--	6.8	8.4	3.5	1.8	.4	--	--	--	20.9
SUPPLEMENTAL TECH DEV	--	1.8	.5	1.0	--	--	--	--	--	3.3
MISSION OPS & DATA ANALYSIS	--	--	--	.2	.2	.2	--	--	--	.6
TOTAL	--	8.6	8.9	4.7	2.0	.6	--	--	--	24.8

Earth Observing System

Before the Earth Observing System (EOS) was authorized in November 1990 in the FY 1991 budget as a new start, EOS planning had been in progress for over eight years. The EOS is key to achieving the objectives set forth in the Mission to Planet Earth program plan and the overall goal and scientific objectives of the interagency U.S. Global Change Research Program. EOS is an international science program, drawing upon the contributions of Europe (ESA), Canada, and Japan both in terms of spacecraft and instruments. This extraordinary collaboration is essential to reach the objective of providing long-term (15 years), comprehensive measurements of the nature of global climate change.

At its outset, the EOS program was based on the flights of two series of large platforms, in addition to platforms from Japan and ESA and instruments carried on Space Station Freedom. Although EOS was understood to be a program having a 15-year period of flight operations, the initial estimates provided to Congress focused on the period through fiscal year 2000. The initial estimate of $18-21 billion included development, mission operations, data analysis, launch services, communications, construction of facilities and the amounts carried in the Space Station program for the polar platform's development. In the FY 1992 appropriations process, Congress directed NASA to modify the scope and cost of the program. The cost through FY 2000 was to be reduced by $5 billion, the FY 1993 funding level had to be reduced, and NASA was to examine the feasibility of using smaller platforms. In 1991, the program was restructured to employ five smaller flight series. In 1992, in response to the

approximately $0.9 billion, of which $0.3 billion reflected an accounting transfer for small business innovative research out of individual programs into a common NASA account, and $0.1 billion reflected the change to lower-cost launch vehicles. The further reductions in program funding were addressed in 1994 through a program rebaselining activity. A number of small spacecraft were introduced into the program flight plans. In addition, alterations were made in flight phasing and accommodations were provided for a follow-on instrument to the enhanced thematic mapper being flown in 1998 on Landsat-7. Funding for the science investigations and data analysis was separated from the algorithms being developed to convert the instrument data into information. This change recognized the close relationship to similar science investigations and data analysis funded in the Mission to Planet Earth research and analysis account. (The amounts budgeted for EOS science are shown in the table below.) In addition, it was decided to incorporate the development funding for the Landsat-7 into the EOS program in light of the integral ties between the two activities.

In the FY 1996 budget process, the amounts reflected the related program costs for Landsat-7's activities previously funded by the Department of Defense.

The budgetary estimates below represent funding included in the Science, Aeronautics and Technology appropriation. The amounts below reflect the effects of the rescoping of the EOS program, the impacts of the ZBR, and the inclusion of the estimate for FY 2002. They do not include the costs of the non-program-unique government facilities and general and administrative support used to carry out the research and development activities. A more detailed description of the program goals, objectives and activities is provided in the specific budget justification narrative for the program within the Mission to Planet Earth section.

(Budget Authority in Millions of Dollars)

Earth Observing System	**Prior**	**1996**	**1997**	**1998**	**1999**	**2000**	**Subtotal Through Fy 2000**	**2001**	**2002**
MORNING SERIES	843.9	178.7	82.8	49.1	39.0	160.6	1,354.1	199.0	195.0
AFTERNOON SERIES	203.2	103.7	149.7	218.0	118.1	63.3	856.0	117.0	185.6
CHEMISTRY	21.8	27.3	63.3	100.6	149.1	143.6	505.7	76.0	49.2
SPECIAL SPACECRAFT	142.6	60.5	83.1	91.7	123.8	146.3	648.0	121.1	95.8
LANDSAT 7 DEVELOPMENT	184.0	85.2	76.2	52.1	2.0	1.5	401.0	--	--

ALGORITHM DEVELOPMENT	194.7	73.3	84.9	102.7	131.2	153.5	740.3	134.6	136.4
TECHNOLOGY INFUSION	1.0	25.5	46.7	65.5	55.5	65.5	259.7	65.5	65.5
EOSDIS	653.2	247.2	254.6	244.7	287.5	271.7	1,958.9	268.1	267.5
SUBTOTAL	2,244.4	801.4	841.3	924.4	906.2	1,006.0	6,723.7	981.3	995.0
PHASE B	41.0	--	--	--	--	--	41.0	--	--
SPACE STATION PLATFORM	104.0	--	--	--	--	--	104.0	--	--
TRACKING AND DATA SUPPORT	--	.4	--	--	.1	.1	.6	.2	.1
EOS SCIENCE	37.3	16.7	22.4	30.3	32.5	42.5	181.7	43.7	39.7
LAUNCH SERVICES	67.1	86.8	65.5	84.3	55.8	47.2	406.7	57.5	57.3
CONSTRUCTION OF FACILITIES	79.7	17.0	--	--	--	--	96.7	--	--
TOTAL EXCLUDING CIVIL SERVICE COSTS ($M)	2,573.5	922.6	930.5	1,039.0	994.6	1,095.8	7,554.4	1082.7	1092.1
(ESTIMATED CIVIL SERVICE FTEs)	(1954)	(647)	(821)	(842)	(838)	(791)	--	(792)	(792)
CIVIL SERVICE COMPENSATION ESTIMATE ($M)	125.7	46.6	63.3	68.2	66.3	63.6	--	65.4	69.3

Earth Probes

The Earth Probes program consists of spacecraft and instrument developments to address specific, highly-focused mission requirements in Earth science research. They are complementary to the scientific data-gathering activities carried out within the EOS program. The currently approved Earth probes are the Total Ozone Mapping Spectrometer (TOMS), NASA Scatterometer (NSCAT), and the Tropical Rainfall Measuring Mission. The Earth System Science Pathfinder missions will be funded to take advantage of the new technologies

in spacecraft and instrument design being developed by other federal agencies and by NASA. The Experiments of Opportunity funding will accommodate opportunities to provide flight instruments and technologies on non-Mission to Planet Earth missions, foreign or domestic, or on airborne experiments. The Lewis and Clark missons were transferred from Advanced Concepts and Technology. The "lightSAR" program is consistent with direction included in House Report 104-812.

The budgetary estimates below represent funding included in the Science, Aeronautics and Technology appropriation. The program is designed as an ongoing program. The budget estimates immediately below do not include the estimated costs incurred by the international collaborators, mission operations, science costs, launch services, related funding included in the Earth Observing System program, NASA civil service work force salary and expenses, use of government facilities and general and administrative support used to carry out the research and development activities. A more detailed description of the program goals, objectives and activities is provided in the specific budget justification narrative for the program within the Mission to Planet Earth section.

(Budget Authority in Millions of Dollars)									
Earth Probes	**PRIOR**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**TOTAL**
NASA SCATTEROMETER	206.8	3.2	--	--	--	--	--	--	210.0
TOTAL OZONE MAPPING SPECTROMETER	104.5	3.0	1.0	5.7	3.4	4.7	--	--	122.3
TROPICAL RAINFALL MEASURING MISSION	202.3	25.5	17.7	--	--	--	--	--	245.5
LEWIS & CLARK	74.4	42.6	5.0	5.0	5.0	--	--	--	132.0
"LightSAR"	--	--	12.0	--	--	--	--	--	12.0
EARTH SYSTEM SCIENCE PATHFINDERS	--	1.0	19.4	29.4	73.4	73.3	73.2	73.2	Continues
EXPERIMENTS OF OPPORTUNITY	--	4.8	2.1	.6	.4	5.3	5.3	5.3	Continues

EOS New Millennium Program and Technology Infusion

The New Millennium Program (NMP) and Technology Infusion budget reflects a

commitment to develop new technology to meet the scientific needs of the next few decades and to reduce future EOS costs. The program objectives are to spawn "leap ahead" technology by applying the best capabilities available from several sources within the government, private industries and universities. The first mission EO-1, has been selected to demonstrate innovative technology to produce Landsat data. The EO-2 mission has not been selected.

(Budget Authority in Millions of Dollars)								
EOS New Millennium Program and Technology Infusion	**PRIOR**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
EO-1	--	7.8	35.0	26.0	5.0	--	--	--
EO-2 (*PLANNING ESTIMATE*)	--	--	--	4.0	4.0	4.0	4.0	4.0
LAUNCH SERVICES	--	2.3	6.0	15.5	12.0	2.3	38.1	--
NMP TECHNOLOGY & FUTURE FLIGHTS	1.0	12.2	--	10.0	31.0	36.0	36.0	36.0
SENSOR & DETECTOR TECHNOLOGY	--	5.5	4.7	5.5	5.5	5.5	5.5	5.5
INSTRUMENT INCUBATOR	--	--	7.0	20.0	10.0	20.0	20.0	20.0
TOTAL EXCLUDING CIVIL SERVICE COSTS ($M)	1.0	27.8	52.7	81.0	67.5	67.8	103.6	65.5

Scatterometer

NASA began the development of the NASA Scatterometer (NSCAT) in October 1984 as a host instrument on the Navy Remote Sensing Satellite (N-ROSS). The N-ROSS program was canceled in March 1988. In August 1989, NSCAT was selected by the Japanese space agency for their planned Advanced Earth Observing System (ADEOS) mission. The instrument's design was altered to allow it to be accommodated on the ADEOS. The Japanese launched the ADEOS spacecraft on their H-II launch vehicle on August 17, 1996.

(Budget Authority in Millions of Dollars)

Scatterometer									
Scatterometer	**PRIOR**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**TOTAL**
DEVELOPMENT	206.8	3.2	--	--	--	--	--	--	210.0
MISSION OPERATIONS	--	2.4	4.2	4.2	3.0	--	--	--	13.8
SCIENCE TEAMS	--	--	4.6	3.9	3.9	--	--	--	12.4
TOTAL EXCLUDING CIVIL SERVICE COSTS ($M)	206.8	5.6	8.8	8.1	6.9	--	--	--	236.2

Total Ozone Mapping Spectrometer

The TOMS Earth Probes program is a follow-on to the Total Ozone Mapping Spectrometer (TOMS) instrument flown with such great success on the Nimbus-7 spacecraft in 1978. A TOMS instrument was also flown on the Russian METEOR spacecraft in 1991. The TOMS program consists of a set of instruments (flight models 3, 4, 5) and one small spacecraft. Flight model 3 was launched on the TOMS Earth probe spacecraft on July 2, 1996. Flight model 4 was launched on the Japanese ADEOS spacecraft on August 17, 1996. Flight model 5 is currently planned for a cooperative mission with the Russian Space Agency in the year 2000.

(Budget Authority in Millions of Dollars)									
Total Ozone Mapping Spectrometer	**PRIOR**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**TOTAL**
DEVELOPMENT	104.5	3.0	1.0	5.7	3.4	4.7	--	--	122.3
MISSION OPERATIONS	9.2	1.3	1.0	2.8	1.8	3.5	3.5	3.6	26.7
SCIENCE TEAMS	--	1.3	1.0	2.8	1.8	3.5	3.5	3.6	17.5
SELV	16.7	--	--	--	--	--	--	--	16.7
TRACKING (TOMS EARTH PROBE)	4.4	.7	.3	.3	.3	--	--	--	6.0
TOTAL EXCLUDING CIVIL SERVICE COSTS ($M)	134.8	6.3	3.3	11.6	7.3	11.7	7.0	7.2	189.2
(ESTIMATED CIVIL SERVICE FTEs)	(126)	(12)	(8)	(10)	(11)	(9)	(1)	(1)	--
CIVIL SERVICE COMPENSATION ESTIMATE ($M)	8.1	0.9	0.6	0.8	0.9	0.7	0.1	0.1	--

Tropical Rainfall Measuring Mission

(Budget Authority in Millions of Dollars)									
Tropical Rainfall Measuring Mission	**PRIOR**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**Ba**
DEVELOPMENT	202.3	25.5	17.7	--	--	--	--	--	--
EOS-FUNDED INSTRUMENTS/SCIENCE/DIS	[18.0]	[21.9]	[10.3]	[8.8]	[12.6]	--	--	--	
MISSION OPERATIONS	--	--	.8	7.9	7.8	7.7	8.3	10.6	
SCIENCE TEAMS	--	--	.5	11.7	12.7	12.8	13.1	2.7	
RESEARCH & ANALYSIS-FUNDED SCIENCE	23.6	5.9	5.9	--	--	--	--	--	
TRACKING	8.5	2.9	2.1	1.3	.2	.2	.2	--	
TOTAL EXCLUDING CIVIL SERVICE COSTS ($M)	234.4	34.3	27.0	20.9	20.7	20.7	21.6	13.3	
(ESTIMATED CIVIL SERVICE FTEs)	(544)	(50)	(128)	(31)	(2)	(2)	(2)	(2)	
CIVIL SERVICE COMPENSATION ESTIMATE ($M)	36.0	3.6	9.9	2.5	0.2	0.2	0.2	0.2	

TDRS Replenishment Spacecraft Program

The Tracking and Data Relay Satellite (TDRS) Replenishment Spacecraft program ensures sufficient spacecraft will be available to continue Space Network operations into the next century. The program provides three additional TDRS satellites and ground terminal modifications through a fixed price, commercial practices contract with Hughes Space and Communications Company. This innovative approach has deleted or greatly reduced Government specifications and documentation requirements, allowing the contractor to substitute commercial practices; this has resulted in efficiencies in both cost and development lead time.

These satellites will incorporate Ka-band frequencies, where space research has a primary allocation, into the high data rate services provided via the high gain, single access antennas. The single access services at S-band and Ku-band will be retained, remaining backward compatible with the existing, first generation TDRS satellites. These satellites will also provide

an enhanced multiple access service with data rates up to three megabits per second. The first spacecraft remains on schedule for launch in the third quarter of 1999. The FY 1998 budget proposes multi-year appropriations for development of TDRS. This will ensure the stability to manage and execute this program within its budget and schedule commitments.

The estimates do not include costs for use of government facilities and general and administrative support used to carry out the program. A more detailed exposition of the program goals, objectives and activities is provided in the specific budget justification for the program within the Space Communications section.

(Budget Authority in Millions of Dollars)										
TDRS Replenishment Spacecraft Program	**PRIOR**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**Balance**	**TOTA**
SPACECRAFT DEVELOPMENT AND GROUND TERMINAL MODIFICATIONS	47.6	147.2	162.1	107.0	69.3	37.8	19.8	16.4	19.9	627.
LAUNCH SERVICES	2.0	3.2	17.9	50.5	51.1	20.2	50.2	81.8	32.7	309
TOTAL EXCLUDING CIVIL SERVICE COSTS ($M)	49.6	150.4	180.0	157.5	120.4	58.0	70.0	98.2	52.6	936
(ESTIMATED CIVIL SERVICE FTEs)	(29)	(36)	(42)	(48)	(52)	(37)	(37)	(37)	--	
CIVIL SERVICE COMPENSATION ESTIMATE ($M)	1.8	2.6	3.2	3.9	4.1	3.0	3.1	3.2	--	

X-33 Advanced Technology Demonstrator

The X-33 program will demonstrate, on the ground and on a flight demonstration vehicle, technologies and operations concepts that could reduce space transportation costs to one-tenth of their current level. The National Space Transportation Policy directed the X-33 program to include two major decision points. The first decision, whether to proceed with the demonstration phase (Phase II), was made in July 1996 based on specific programmatic, business planning and technical criteria which had previously been agreed upon by NASA, the Office of Management and Budget and the Office of Science and Technology Policy. With Administration approval, Lockheed Martin Skunkworks, Palmdale, CA was chosen as the X-33 industry partner. X-33 flight tests are expected to begin in March, 1999. The second decision will be made at the end of the decade, after X-33 ground and flight tests, when Government and industry will consider whether private financing of the full-scale development of an operational RLV (Phase III) should be pursued.

NASA is utilizing an innovative management strategy for the X-33 program, based on industry-led cooperative agreements. As a result of industry's leadership of the program, Government participants are acting as partners and subcontractors, performing only those tasks which offer the most effective means to accomplish the program's goals. The Government participants report costs and manpower to the industry team leader as would any other subcontractor. Every NASA center except the Goddard Space Flight Center has a negotiated role on the X-33 program. The Industry-led cooperative arrangement allows a much leaner management structure, lower program overhead costs and increased management efficiency. The FY 1998 budget proposes multi-year appropriations for development of the X-33. The initiative will ensure the stability to manage and execute this program within its budget and schedule commitments.

As directed by Congress, the X-33 program funding includes $10.5 million in Construction of Facilities funding and $35.0 million in equipment funds in FY 1996 for completion of the Component Test Facility at Stennis Space Center. The X-33 program also funds refurbishment of the B-2 test stand at Stennis in FY 1997 ($2.3 million) and FY 1998 ($3.7 million) to enable testing of X-33 and development and flight engines. Civil Service estimates below are for the X-33 cooperative agreement only.

A more detailed description of the program goals, objectives and activities is provided in the specific budget justification narrative for the program.

(Budget Authority in Millions of Dollars)										
X-33 Advanced Technology Demonstrator	**PRIOR**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**Balance**	**TOTA**
TOTAL EXCLUDING CIVIL SERVICE COSTS ($M)	--	157.5	246.8	333.5	313.9	75.0	--	--	--	1126.
(ESTIMATED CIVIL SERVICE FTEs)	--	(59)	(240)	(277)	(273)	(65)	--	--	--	
CIVIL SERVICE COMPENSATION ESTIMATE ($M)	--	5.1	30.8	32.4	40.7	10.0	--	--	--	